5. IDENTIFICATION OF AREAS OF POTENTIAL SOIL INSTABILITY AND/OR FAULT RUPTURE THROUGH AERIAL PHOTOS AND GEOMORPHOLOGICAL STUDIES

5.1 INTRODUCTION

The geomorphologic investigation yields information about specific topographic features (*e.g.* sharp ridges) and landforms of particular interest for microzoning purposes (*e.g.* paleo-hydrography elements). The geomorphological study is also a useful contribution to constrain earthquake ground shaking scenarios.

The geomorphological study of the municipal area of about 182 km^2 of Catania was performed through photo interpretation.

The use of aerial photographs for geomorphologic investigations is well know, and the major advantages of the photo interpretation over other methods of ground investigation are:

- the aerial photos give direct information on the landscape;
- the landform features can be better studied on a wide scale using synoptic coverages, and the synoptic overview allows to study various spatial features in relation to one another;
- the stereoscopic view allows suitable evaluation of slopes and forms, and the vertical exaggeration in stereo viewing highlights several morphological details;
- the procedure is time saving, as information about a large area is quickly delivered;
- photo interpretation is generally much less expensive than ground investigations;
- photo interpretation delives information about some areas that may not be accessible to ground survey;
- the use of different surveys of different ages may be useful for some tasks, where the temporal resolution depends upon the dynamics of the situation.

The geomorphic criteria adopted for the recognition for example of landslides and their state of activity are clearly subjective, and the photo interpretation results may be closely dependent on the analyst.

5.1.1 Aerial photos

We used two different aerial photographs surveys: GAI flight, and Volo Italia 1994 flight.

The GAI flight is a black-and-white coverage of the whole Italian territory, with 1:33,000 nominal scale, carried out in 1955. These vertical photos show technical quality adequate for our task and allow an accurate mapping of landscape features because of the poor urbanisation in the 1955. In the geomorphic study of urban area of Catania, we preferred to interpret older photos because the recent urban development has often masked the natural landscape.

The Volo Italia 1994 flight is a panchromatic survey of Italy, at scale 1:75,000, carried out in 1994 by *Compagnia Generale Ripreseaeree*. This coverage is performed with new technology photogrammetric cameras. This survey shows excellent technical quality and high resolution.

The use of the two surveys allows to study the dinamics of the landforms, and the ground resolution of the photos allows to identify the elements of interest and obtain a considerable detail.

5.2 GEOMORPHOLOGICAL STUDY

Numerous landforms in the Catania area can be reliably recognised on air photos, different geomorphologic units have different topographic and tonal characteristics. Differences in vegetation, moisture content, and soil or rock composition account for most tonal contrasts. On aerial photographs the boundary between coherent and unconsolidated material can be recognised, as well as different lithologies.

In the municipal area of Catania the lithological discrimination is made possible by the composite effect of tone, texture, landform, topography, drainage pattern and vegetation. The whole area is divided into four different rock types recognised on the air photographs.

The different photo-recognised lithologies are:

Rock A: products of the volcanic activity. Lavas show distinctive surface features, are resistant to erosion, and form caracteristic positive topographic features.

We identified a relatively fresh lava flow in the northern part of the study area, between the localities Canalicchio and Barriera del Bosco. The topography is very rough and irregular, the vegetation was sparse in the 1955, and the older flows are difficult to be identified. This lava flow is easily recognised on the 1955 photos, and it is masked by the intense urbanisation on the 1994 photos.

Rock B: incompetent and easily eroded sedimentary products. These products form the Simeto Valley, and are intensely used for agricultural purposes. They are made of fluvial, lacustrine and marine deposits, and terrigenous materials as shale, sandstone and limestone. Although the photographic tone is highly variable with space, the wet deposits are usually dark-toned, since water-rich deposits are less reflectant than the neighbouring deposits.

Rock C: moderately resistant sedimentary deposits. They form low hills and topographically prominent features. The ridges are rounded, the drainage is developed, and valleys tend to be U-shaped. This lithology is used for agricultural purposes, is made of terrigenous material as sandstone and conglomerate.

Rock D: generally resistant sedimentary rock. They form hills, the elevations are higher than for Rock C, and the ridges are sharp enough. The drainage is well developed, and valleys tend to be V-shaped. The vegetation is poor. Immediately to the West of the study area, in localities Valanghe d'Inverno e Portella dei Sieli, the drainage pattern is dendritic, the drainage density is higher, and the gullies show steeper cross-sections forming the characteristic badland topography.

Through the photo interpretation we detected a wide range of landforms due to different processes in the municipal area of Catania. In particular we recognised depositional and erosional landforms due to fluvial, marine, volcanic processes, and due to slope instability. At last we paid a special attention to the human landforms as quarries, fills, anthropic scarp, and check dams. Figure 5.1 shows the resuts of the geomorphological photo interpretation.

5.2.1 Slope instability landforms

We identified three significant landslides in the northern part of the Catania city, as shown in Table 5.1.

They appear similar with regards to lithological make-up and geomorphical setting. The three landslides are located on a slope of the southern flank of the M. Etna, which is made up of lava rocks. The headscarps are sharp break lines in the topography, and the landslide bodies are peculiar hummocky topography on the down-slope side.

Table 5.1. Identified landslides in the northern part of Catania

ID	Locality	Areal extent
1	Sgroppillo- Nizzetti	1.3 km^2
2	M. S. Sofia	0.7 km^2
3	Borgo	1.0 km^2

These landslides are dormant, since they do not show fresh landforms or well defined surface features typical of landslides. These landslides are easily recognised on the 1955 photos, and they are masked by the intense urbanisation on the 1994 photos.

A small active landslide is located in locality C. di Geronimo, 3 km East of Misterbianco. The landslide is a flow, and it usually occurs in clay-bearing rocks under satured conditions and then it is related to precipitation. The surrounding slopes affected by an imperceptibly slow downward movement of soil, the soil creep.

Several landslides are located in locality S. Demitri, on the southern slopes of the hilly relief to the South of the Simeto flood plain. These mass movements are essentially active flows. In the sedimentary outcrops are clearly present clayey layers. Numerous check dams are recognised in this area, they are small dams designed to reduce water velocity and control the erosion.

Debris is an accumulation of fragments of rock. Debris are recognised near Catania and the Villaggio N.A.T.O.

5.2.2 Fluvial landforms

Several elements of palaeodrainage are recognised in the air photographs. Deposits which are rich of water absorb more light and are dark-toned, and the shape of cultivated lands helps us to recognise the location of ancient meander or braided courses.

The Simeto River and its two tributaries, the Dittaino River and the Gornalunga River, flow in an open floodplain through highly erodible alluvium. The meander migration and the cutoff formation are the natural evolution of a meandering river like the Simeto River. However the coastal cutoff located near the Simeto mouth is probably due to the human activity. It determined the formation of a oxbow lake. The cutoffs near Mass. di Mauro and near the Simeto mouth have occurred after the 1955 and before the 1994.

The scarce fluvial terraces of the study area, with the exclusion of Simeto terraces forming the Catania plain, are located southwest Catania, near Fossa della Creta.

Alluvial fans occur along the coastal plain on the southern sides of the relief. They are free to expand on the piedmont plane. In the southern area of the municipality the active fans are associated with active landslides.

In the city of Catania we recognised two areas of preferred water flow direction. They are characterised by low relief in relation to the neighbouring areas.

5.2.3 Volcanic/structural landforms

We recognised a NNE-SSW lineament in the northern part of the study area. The term *lineament* has been extensively used often with different meanings. We applied this definition: "a lineament is a mappable simple or composite linear features of a surface whose parts are aligned in a rectilinear or slightly curvilinear relationship and which differs distinctly from the pattern of the adjacent features and presumably reflects a subsurface phenomenon" (O'Leary, 1976). We identified this alignment of ridges, and scarps, even a secondary scarp of the Ficarazzi landslide, from the locality Valverde, to the North, to Porto d'Ulisse, to the South.

5.2.4 Marine landforms

The marine terraces are recognised due to their topographic signature. The terrace is a flat bench generally separated from the younger terrace below or from the coastal plain by a steep slope. The correlation of the various terrace patches was based on geomorphic criteria. In particular on the lateral continuity of slightly remodelled remnants, the accordance of elevation of more remnants at short distance, the similarity of the vertical spacing between terraced remnants, and the equivalence in the position of more remnants in different terraced sequences.

We identified two orders of marine terraces above the Simeto plain, the elevation of the back edge of the younger terrace is of about 90 m asl.

The marine deposits are obviously located along the coast, with the exclusion of the northern part of the Catania municipality, made of recent products of the volcanic activity. They are composite products, due to the sea, the river and the wind actions. The coastal area is covered with linear dunes. The aerial photos help in locating the submerged bars in front of the coast.

5.3 CONCLUSION

The geomorphologic study was carried out through air photo interpretation with no ground checking.

Commonly photo-geology is not an alternative to fieldwork, but a close integration of field survey and photo-interpretation is desirable in order to obtain good, fast, and cheap results.

A preliminary photo-geological study will considerably reduce the amount of drilling to be done. Key areas may be quickly identified, where wells can be realised in a minimum number with a minimum of time, effort, and costs. The spacing of wells will depend on the homogeneity of the region.

An important advantage of mapping from photo-interpretation is the overall view of the study area.

Airphotos of 1955 are very important since they provide the overall geomorphologic picture preceding urbanisation, in a present-day very urbanised area like Catania.

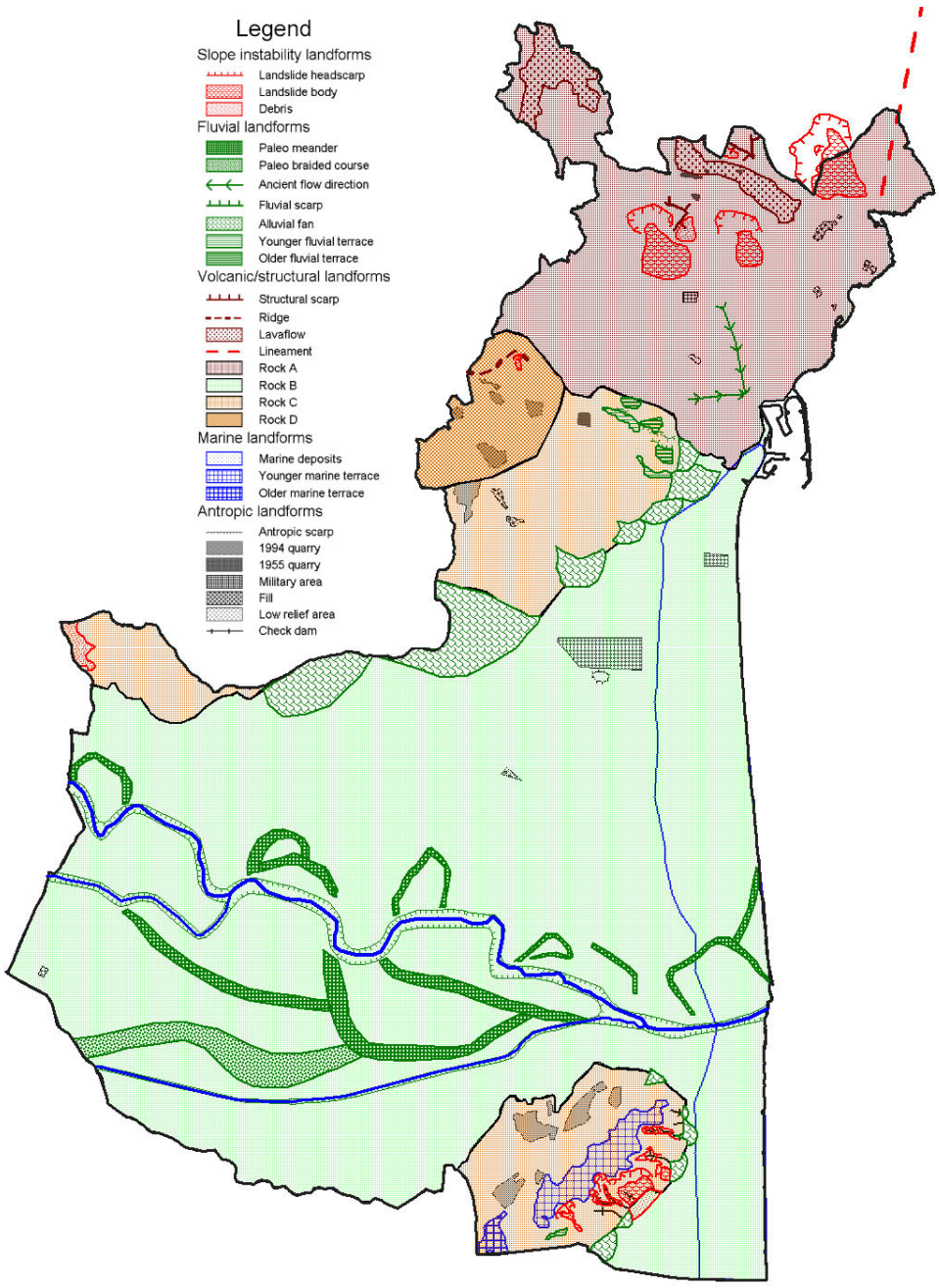

Figure 5.1. Geomorphologic map of Catania generated through air photo interpretation